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STATE DOCUMENTS

ENGINEERING REPORT  
FOR  
COMPARISON OF COSTS  
OF  
ALTERNATE LINES  
ON  
INTERSTATE ROUTE 94

**HYSHAM-FORSYTH**

PREPARED BY  
MONTANA STATE HIGHWAY COMMISSION  
INTERSTATE DIVISION

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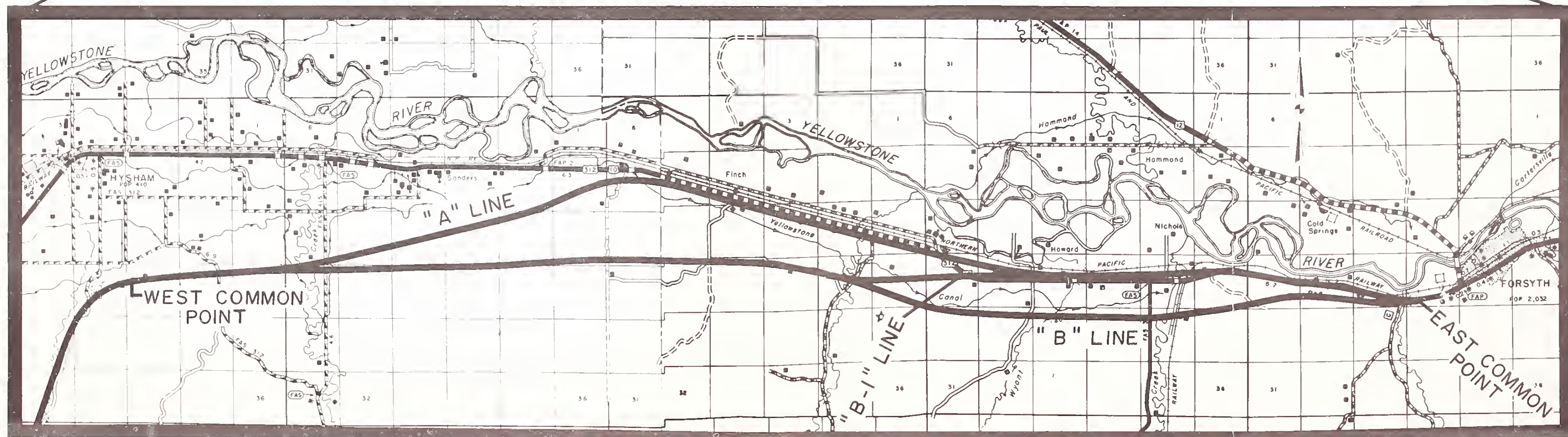


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## ALTERNATE LOCATIONS STUDIED





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ECONOMIC ANALYSIS OF ALTERNATE  
LOCATION FOR INTERSTATE ROUTE 94  
HYSHAM TO FORSYTH

July 15, 1963

FOREWORD

An economic analysis of this type is prepared for the purpose of presenting factual data which may be used in determining the most favorable highway routing where more than one routing is under consideration. Although this type of analysis deals with many features of highway location, its principal function is to evaluate those considerations that can be reduced to monetary terms. These considerations include the cost of constructing the alternate routes, the cost of maintaining each route and the cost that will be incurred by the highway-user in traveling on each route.

The cheapest route to construct or maintain does not always provide the best service to the highway-user; therefore, it is necessary to consider vehicular operating costs in determining the route which provides the greatest overall benefit. Since Federal and State funds for the support of highways are obtained almost entirely from highway-user taxes, the most favorable routing from the standpoint of the highway-user would be the route that has the lowest overall cost when all construction, maintenance and vehicular operating costs are taken into consideration.

This report deals with determining the most favorable routing of Interstate 94 from a point south of Hysham to a point west of Forsyth. Three alternate routings will be evaluated in this report. They will be referred to as the A Line, B Line and B-1 Line.

DESCRIPTION OF THE ROUTES

Due to their lengths, the routes will be described in sections.

A LINE

The A Line begins at the West Common Point approximately one-half mile east of the Hysham Interchange at Station 865 + 00. It bears in an easterly direction through grazing and dryland cultivation to a point just west of Sarpy Creek at approximately Station 1000+. This section is common to all lines and features a separation of the Secondary Road, FAS 312, at Station 950+ and a rest area at Station 970+. The rest area will serve both eastbound and westbound traffic.

The A Line then bears in a northeasterly direction to the Treasure-Rosebud County Line. It passes through irrigated farmland in the Sarpy Creek bottom and also near the county line. The rest of the land traversed in this section is grazing and dryland cultivation. An Interstate structure over Sarpy Creek, a diamond interchange with FAS 415 (locally known as the Sarpy Creek Road) and a diamond interchange just west of the county line are provided in this section.



The A Line then parallels the south side of US 10 from the county line to a curve approximately three miles west of the Colstrip Road. It then crosses present US 10 and parallels the north side of US 10 to the Colstrip Railroad Spur. The A Line traverses irrigated farmland and marshy grazing land through the above section. Public access facilities provided in this section are an at-grade connection with a local road at Station 1476+, an Interstate separation structure at the Reservation Creek Road, a frontage road on the right side of the Interstate from the Reservation Creek Road to present US 10 near Howard, an at-grade connection on the left with a local road at Station 1781+ and a diamond interchange with the Colstrip Road. Physical problems of terrain and close proximity to the Northern Pacific Railroad requires the A Line to generally overlay present US 10 from the Colstrip Railroad Spur to the East Common Point. This section is grazing land. An at-grade connection is provided with a local road near the East Common Point. An at-grade was used for the purposes of preparation of this report because the access solution for this road is contingent on the location of the Interstate east of the East Common Point. The A Line will eliminate a roadside park at Station 2110+ which has a developed spring that is used extensively by the motoring public and residents of Forsyth.

## B Line

The B Line begins at the West Common Point near the Hysham Interchange and is coincident with the previously described A Line to a point just west of Sarpy Creek at approximately Station 1000+. The features of the common section were discussed under the A Line description.

The B Line continues in an easterly direction to the Treasure-Rosebud County Line. It passes through grazing and dryland cultivation with the exception of a short section of irrigated farmland in the vicinity of Sarpy Creek. A diamond interchange is provided with the Sarpy Creek Road. The interchange separation is local road structured over the Interstate. A local road at Station 1335+, which serves an extensive grazing and dryland area to the south of the B Line, is also separated. This separation is proposed as local road over the Interstate.

The B Line then continues in an easterly direction for approximately two miles where it descends a coulee into Reservation Creek. It then climbs out of Reservation Creek and drops back down into grazing and dryland cultivation bordering irrigated farmland. The B Line parallels a pipeline from this point to the Colstrip Road. This section features a stock and machine pass for a local road at Station 1439+, an Interstate structure over Reservation Creek, the Reservation Creek Road structured over the Interstate and a diamond interchange is provided for the Colstrip Road. The local road is structured over the Interstate at the Colstrip Interchange.

The B Line traverses a hilly area from the Colstrip Road to the East Common Point. The Interstate is structured over Armells Creek, the Northern Pacific Spur to Colstrip and Smith Creek. The B Line passes south of the previously mentioned roadside park on US 10. An at-grade connection is provided for the local road and golf course near the East Common Point. This was used for the report only, as was pointed out in the description of the A Line.





## B-1 LINE

The B-1 Line is coincident with the B Line to a point just west of Reservation Creek. The B-1 Line descends into Reservation Creek in the same coulee as the B Line. It is structured over Reservation Creek and the Reservation Creek Road. From this point the B Line bears in an easterly direction, passing through a hilly area and descending into irrigated farmland. It traverses irrigated land and connects with the A Line approximately one-half mile west of Wyants Coulee. Present US 10 is re-aligned and structured over the B-1 Line to integrate the local road system. The B-1 Line is then coincident with the A Line to the East Common Point near Forsyth.

## ESTIMATING PROCEDURE

The following is a description of the procedures followed in developing the estimated construction costs for each of the alternate Interstate Highway locations.

### Earthwork

Through the use of photogrammetry, contour maps were prepared for all routes. The most favorable lines were selected and the profiles established. Grades were set and earthwork quantities were computed from charts which relate height of fill and depth of cut and cross-section elements to earthwork volumes.

### Drainage

The cost of minor drainage pipes (less than 72" in diameter) was estimated on the basis of the average cost per mile. Where larger pipes were required, the cost was developed on the basis of individual requirements for each route.

### Base and Surfacing

Base and surfacing costs were computed on the basis of the two-lane typical section indicated in this report.

### Structures

The structures were estimated on the basis of cost per lineal foot according to lengths and widths involved.

### Right-of-Way

Right-of-way estimates were prepared by the Right-of-Way Division.





# CONSTRUCTION COSTS

ITEM	LIFE	6% CRF	A LINE		B LINE		B-1 LINE	
			TOTAL	ANNUAL	TOTAL	ANNUAL	TOTAL	ANNUAL
1. Right of Way	50	0.0634	\$ 312,000	\$ 19,780	\$ 139,000	\$ 8,810	\$ 301,000	\$ 19,080
2. Structures	50	0.0634	677,000	42,920	540,000	34,240	616,000	39,050
3. Grade, Drain, Machine Passes	40	0.0665	1,467,000	97,550	1,466,000	97,490	1,518,000	100,950
4. Base and Surface - Mainline	20	0.0872	1,804,000	157,310	1,638,000	142,830	1,698,000	148,070
5. Interchanges - Frontage Roads								
Complete (Less Structures)	30	0.0726	389,000	28,240	202,000	14,670	257,000	18,660
6. Guardrail	20	0.0872	54,000	4,710	134,000	11,680	125,000	10,900
7. Fencing	20	0.0872	147,000	12,820	145,000	12,640	144,000	12,560
8. Rest Area	30	0.0726	30,000	2,180	30,000	2,180	30,000	2,180
9. Traffic Control Devices	20	0.0872	60,000	5,230	45,000	3,920	45,000	3,920
10. Utility Adjustments	40	0.0665	52,000	3,460	19,000	1,260	53,000	3,520
11. Seeding & Mulching	20	0.0872	74,000	6,450	73,000	6,370	72,000	6,280
12. SUBTOTAL ITEMS 2-12			\$4,754,000		\$4,292,000		\$4,558,000	
13. Preliminary Engineering (4.8% Line 12)	40	0.0665	\$ 228,000	\$ 15,160	\$ 206,000	\$ 13,700	\$ 219,000	\$ 14,560
14. Construction Engineering & Contingencies (10% Line 12)	40	0.0665	\$ 475,000	\$ 31,590	\$ 429,000	\$ 28,530	\$ 456,000	\$ 30,320
15. TOTAL			\$5,769,000	\$427,400	\$5,066,000	\$378,320	\$5,534,000	\$410,050



The preceding table shows estimated initial costs and amortized annual costs based on a 6% capital recovery factor. The table shows a total initial cost of \$5,066,000 for the B Line as compared with \$5,769,000 for the A Line and \$5,534,000 for the B-1 Line.

The estimated initial cost of the B Line is \$703,000 less than the A Line and \$468,000 less than the B-1 Line. The amortized annual costs are \$49,080 more for the A Line and \$31,730 more for the B-1 Line. It can be seen that the B Line is the best with respect to construction costs.

### CONSTRUCTION FEATURES

The following table presents a comparison of the principal construction features involved in each of the alternate routes:

	<u>A LINE</u>	<u>B LINE</u>	<u>B-1 LINE</u>
Construction length in miles	24.50	24.15	24.05
Miles of 2-lane construction	24.50	24.15	24.05
Miles of new frontage road	1.63	- 0 -	0.74
Number of interchanges	3	2	2
Number of highway separations (without ramps) -----	2	3	4
Number of railroad separations	1	1	1
Number of bridges	5	4	5
Length of grades over 3.0%(in miles) - 0 -	- 0 -	- 0 -	- 0 -
Maximum grade	3.0%	3.0%	3.0%

### MAINTENANCE COSTS

<u>TYPE OF HIGHWAY</u>	<u>MILES TO MAINTAIN</u>	<u>ANNUAL COST PER MILE</u>	<u>ANNUAL COST</u>
<u>A LINE</u>			
Interstate 2-Lane	24.5	\$2,000	\$49,000
Frontage Roads	1.6	500	800
Interchange Ramps	2.5	1,500	3,750
Present US 10	20.0	1,500	30,000
			<u>\$83,550</u>
<u>B Line</u>			
Interstate 2-Lane	24.2	\$2,000	\$48,400
Frontage Roads	—	500	--
Interchange Ramps	1.7	1,500	2,550
P.T.W.	24.8	1,500	37,200
			<u>\$88,150</u>
<u>B-1 Line</u>			
Interstate 2-Lane	24.0	\$2,000	\$48,000
Frontage Roads	0.7	500	350
Interchange Ramps	1.7	1,500	2,550
P.T.W.	20.0	1,500	30,000
			<u>\$80,800</u>

The annual maintenance costs for the B-1 Line would be \$2,700 less than the A Line and \$7,350 less than the B Line.





## TRAFFIC SERVICE

An evaluation of the service provided to traffic by alternate highway locations is an important part of route location studies. In the case of the Hysham-East section of Interstate Route 94, there are three possible travel routings which should be analyzed.

As shown on the enclosed map, the A Line starts at the Hysham Interchange south of that city and extends in a east by northeasterly direction to a point where it reaches the vicinity of present US #10 near the Treasure-Rosebud county line. From this point to the eastern terminus, near Smith Creek, it follows a location closely parallel to the present highway.

Interchanges on the A Line are located on the connecting road south of Hysham, at the intersection with the Sarpy Creek Road (FAS 415), at a point of connection with present US #10 near the Treasure-Rosebud county line and at the intersection with the Colstrip Road (FAS Route 315).

The B Line follows an entirely new location ranging from 2.5 miles to 0.5 miles south of the present highway. This line has interchanges south of Hysham, at the intersection with the Sarpy Creek Road (FAS 415) and at the intersection with the Colstrip Road (FAS 315).

The B-1 Line follows the same location as the B Line from the Hysham Interchange to the highway separation over the Reservation Creek Road. From this point, the B-1 Line follows an easterly projection, crosses the present highway and then follows the same location as the eastern part of the A Line.

The present highway remains intact for traffic service in connection with the B Line. For the A and B-1 Lines, the present highway remains in service with the exception of short sections which are relocated to fit the location for the Interstate System Highway for these lines. For practical purposes, it may be assumed, therefore, that the present local highway service will remain essentially as it now is for all Interstate System locations.

The analysis of traffic service has been made on the basis of the results of an origin-destination survey which was made in the vicinity of Hysham in July, 1959. During this survey, motorists were stopped along the present highway and information was requested concerning trip origins, destinations and intermediate stops. From this type of information, it is possible to determine how the alternate Interstate Highway locations would affect the traffic movements throughout the area.

The interview information obtained during July, 1959, showed that approximately 80% of the vehicles were passenger cars, including panel and pickup trucks and 20% of the vehicles consisted of six-tired and larger trucks. Of the total of 1,194 vehicles using this highway east of Hysham, 907, or about 76% of the vehicles passed through Hysham without stopping. There were 90 vehicles that passed through Hysham on through trips, but these vehicles had some occasion to stop during the passage through the city. These vehicles amounted to about 8% of the total traffic involved. The remaining 197 vehicles, or about 16% of the total traffic, had trip origins or destinations in Hysham or vicinity.





These traffic movements can be further classified as shown below:

<u>Trip Routing</u>	<u>Number of Vehicles</u>
Between Hysham and Sarpy Creek Road -----	21
Between Myers-Hysham area and county line-----	111
Between Myers-Hysham area and Forsyth-East area -----	77
Between Custer-West area and Forsyth-East area (with stop in Hysham) -----	90
Between Custer-West area and Forsyth-East area (non-stop) -----	895
<div style="text-align: right;">TOTAL OF ALL TRIPS</div>	1,194

Experience with freeways throughout the country has shown that motorists do not always use the shortest, fastest or best highways. Analyses of traffic movements via alternate routings show that the choice of facilities is related substantially to the travel time involved via the alternate routes. Travel time ratios have been developed, and from these ratios a curve has been developed for use in determining the diversion of traffic from existing highways to new highways. This curve was used as a guide in estimating the amount of traffic that would continue to use the present highway and the amount of traffic that could be expected to divert to the Interstate highways under consideration.

The assignment of traffic to each of the alternate Interstate System routes has been made by analyzing the possible movements for each of the major traffic categories contained in the foregoing table. In the case of the traffic moving between Hysham and the Sarpy Creek Road south of the proposed interchanges, it is evident that this traffic has the choice of following the present routing via US #10 and FAS Route 415 or traveling south to the Hysham Interchange and then following the Interstate highway to the interchange with FAS Route 415. An analysis of the travel times involved and the application of the travel-time-ratio diversion curve shows that 8 of the 21 vehicles involved would choose to follow the present routing and 13 of the vehicles would follow the new routing via the Interstate highways. This situation applies with similar distribution of traffic to all of the alternate Interstate highway locations.

In the case of the traffic moving between the Myers-Hysham area and the county line, there would be no advantage to this traffic in traveling the substantially greater travel distances involved via the Interstate highway in order to reach the local objective along present US #10. It is assumed that all of the 111 vehicles involved in this movement would continue to use the present highway and none of it would divert to the Interstate routes.

Traffic moving between the Myers-Hysham area and Forsyth and points beyond would have the choice of following present US #10 to the Colstrip Road area or diverting to the Interstate highway for travel between these points. For the A Line, with the interchange of traffic possible near the county line, there would be a greater inclination to use the present highway east of Hysham for a portion of the travel between Hysham and Forsyth. With the other lines, lacking the central interchange facilities, there would be less usage of the present highway and greater usage of the Interstate highways.



DISTRIBUTION OF TRAFFIC BETWEEN PRESENT HIGHWAY  
AND NEW INTERSTATE SYSTEM ALTERNATE LINES

TRAFFIC CATEGORY	VOLUMES	A LINE		B LINE		B-1 LINE	
		PRESENT ROUTING	INTERSTATE ROUTING	PRESENT ROUTING	INTERSTATE ROUTING	PRESENT ROUTING	INTERSTATE ROUTING
Hysham to Sarpy Road	21	8	13	8	13	8	13
Myers-Hysham area to County line (local)	111	111	- 0 -	111	- 0 -	111	- 0 -
Myers-Hysham area to Forsyth-East area	77	35	42	18	59	17	60
Custer-West area to Forsyth-East area with Hysham stop	90	18	72	12	78	11	79
Custer-West area to Forsyth-East area (non-stop)	895	- 0 -	895	- 0 -	895	- 0 -	895
TOTAL	1,194	172	1,022	149	1,045	147	1,047

NOTE: PRESENT ROUTING includes trips which use the present highway for part or all of the trip.  
INTERSTATE ROUTING includes those trips to move entirely between termini without usage of the present highway.



## VEHICLE OPERATING COSTS

After the traffic assignment process has been completed, the problem remains of converting to monetary terms the amount of travel involved on the present highway and each Interstate line in order to determine which of the Interstate lines would permit the lowest vehicle operating cost for the highway user. This objective is accomplished by multiplying the number of vehicle miles of travel involved by each type of highway by unit cost figures for each mile of travel.

The unit cost figures for passenger cars and trucks have been derived from basic vehicle operating cost figures which have been developed by the American Association of State Highway Officials. The unit cost figures used in this report are shown below:

### UNIT VEHICLE OPERATING COST FIGURES (Per Vehicle-Mile of Travel)

<u>TYPE OF HIGHWAY</u>	<u>PASSENGER CARS</u>	<u>TRUCKS</u>
Gravel (FAS 415)	\$.1198	\$.2396
Primary (Present US #10)	.1091	.3115
Interstate	.1022	.2940

It should be explained that the cost per vehicle-mile of travel on gravel road is less for trucks that travel on Primary or Interstate highways for the reason that trucks using FAS Route 415 are of the lighter farm-type vehicles.

The following table shows the vehicle-miles of travel involved on each type of facility for each of the alternate Interstate highway routings and the related vehicle operating costs involved.

### VEHICULAR OPERATING COSTS

- Vehicle-Miles of Travel Involved and Related Operating  
Costs for Alternate Interstate Highway Routings -

<u>TYPE OF HIGHWAY</u>	<u>A LINE</u>	<u>B LINE</u>	<u>B-1 LINE</u>
<u>GRAVEL (FAS 415) \$.1438/VM</u>			
Annual vehicle-miles of travel	5,840	5,840	5,840
Annual vehicle operating cost	\$ 840	\$ 840	\$ 840
<u>PRIMARY (US #10) \$.1496/VM</u>			
Annual vehicle-miles of travel	818,403	798,218	798,219
Annual vehicle operating cost	\$ 122,433	\$ 119,413	\$ 119,413
<u>INTERSTATE \$.1406/VM *</u>			
Annual vehicle-miles of travel	9,488,284	9,340,533	9,303,084
Annual vehicle operating cost	\$1,334,053	\$1,316,081	\$1,308,014
<u>ALL TYPES OF HIGHWAYS</u>			
Annual vehicle-miles of travel	10,312,527	10,144,591	10,107,143
Average cost per vehicle-mile	\$.1413	\$.1416	\$.1413
Annual vehicle operating cost	\$1,457,326	\$1,436,334	\$1,428,267
Average overall trip length	23.663	23.278	23.192
% of travel on Interstate Highway	92.00%	92.07%	92.04%

\*Because of additional rise and fall and grade on the B Line, the average cost is \$.1409 instead of \$.1406.





From the preceding table, it may be noted that the B-1 Line has the lowest annual vehicle operating costs, being \$29,059 per year less than the A Line and \$8,067 per year less than the B Line.

The overall trip length for the B-1 Line is 0.471 less than the A Line and 0.086 less than the B Line. The shorter travel distance for the B-1 Line occurs largely because this line is 0.1 mile shorter than the B Line and 0.5 mile shorter than the A Line. This shorter travel distance is of special benefit to the through travelers who comprise the great majority of the motorists using the present highway.

The traffic analysis shows that the B-1 Line would have the lowest annual vehicle operating cost, and therefore, it would ordinarily be the preferred line from the standpoint of the highway user. It should be noted, however, that the differential between the B-1 Line amounts to less than 1%, and for the A Line the differential is about 2%. The traffic assignment process does not have the degree of basic accuracy to justify a conclusive decision with minor differentials of these amounts. For practical purposes, it may be assumed, therefore, that any of the alternate highway routings would be acceptable from a traffic service standpoint.

#### SUMMARY OF ANNUAL COSTS

The following table summarizes the three basic costs that are deemed to be of greatest significance in evaluating the alternate Interstate highway routings as they are reflected in this report.

COSTS	A LINE	B LINE	B-1 LINE
ANNUAL CONSTRUCTION COSTS	\$ 427,400	\$ 378,320	\$ 410,050
ANNUAL MAINTENANCE COSTS	83,550	88,150	80,800
ANNUAL OPERATING COSTS	<u>1,457,326</u>	<u>1,436,334</u>	<u>1,428,267</u>
TOTAL ANNUAL COSTS	\$1,968,276	\$1,902,804	\$1,919,117
ANNUAL SAVINGS IN FAVOR OF B LINE	\$65,472	---	\$ 16,313

#### CONCLUSION

It is recommended that the alignment designated and detailed as the B Line in this report be accepted as the proper location to be designed and constructed for Interstate 94 from Hysham to Forsyth. Facts, figures and illustrations contained in this report substantiate this recommendation.

This location is the most acceptable of all alternates investigated because:

1. Lowest annual cost.
2. Leaves the present local road system intact.
3. Does the least damage to irrigated farmland.
4. Preserves the roadside park west of Forsyth.



# TYPICAL SECTION

